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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ : C04B 18/30	A1	(11) International Publication Number: WO 91/06513 (43) International Publication Date: 16 May 1991 (16.05.91)
(21) International Application Number: PCT/FI90/00250 (22) International Filing Date: 24 October 1990 (24.10.90) (30) Priority data: 895090 26 October 1989 (26.10.89) FI (71) Applicant (for all designated States except US): LOHJA RAKENNUSMATERIAALIT OY AB [FI/FI]; SF-08700 Virkkala (FI). (72) Inventor; and (75) Inventor/Applicant (for US only) : ERIKSSON, Bo-Erik [FI/FI]; Matinkatu 16, SF-10300 Karjaa (FI). (74) Agent: OY KOLSTER AB; Stora Robertsgatan 23, P.O. Box 148, SF-00121 Helsinki (FI).		(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), LU (European patent), NL (European patent), NO, SE (European patent), US. Published <i>With international search report.</i>
(54) Title: PROCESS FOR PRODUCING AN ACTIVE FINE AGGREGATE FOR THE PREPARATION OF CONCRETE (57) Abstract The invention relates to a process for producing an active fine aggregate, i.e. an active filler, for the preparation of concrete. In the process are ground pozzolanic substances, practically silica, together with inactive and/or weakly active components, as lump slag, which makes it possible to have the silica in the filler in very small particles activating the surfaces of the other components to react easily with the calcium hydroxide.		

Process for producing an active fine aggregate
for the preparation of concrete

In addition to cement and cement binders, also
5 various fine aggregates, as for example so-called
pozzolanic substances, are used as binders in con-
crete. These substances are characterized therein
that they contain glass-like silicon oxide, which re-
acts with the calcium hydroxide generated at a hydra-
10 tation of cement and forms compounds giving strength
to the concrete. To the most used pozzolanas belong
fly ash produced from the combustion of coal and peat
and silica produced from the preparation of silicon.
The reactivity of a pozzolana in concrete is influ-
15 enced except by the chemical composition, also by the
grain size thereof. The grain size of silica is con-
siderably smaller than that of fly ash. As the grain
size of a pozzolana decreases, the need for water in
concrete increases. Therefore, the Finnish concrete
20 standard always presupposes a use of a plasticizer
when silica is used.

The bulk density of the silica produced in the
industry is very low. To transport and dose it as
such into concrete is difficult and even impossible.
25 Attempts have been made to eliminate the problem by
pelletizing the silica into very big pellets with
respect to its grain size. The problems with trans-
port and dosage are thus eliminated, but the silica
does not decompose properly in a concrete mixer,
30 which prevents the silica from acting in the concrete
in the best possible manner. Studies have shown that
undecomposable silica pellets have been found in a
concrete prepared according to the instructions,
which pellets do not provide the concrete with the
35 properties searched for by means of the use of sili-

ca. This problem has been decreased by sludging the silica in water before use. Moreover, admixtures have been used at the sludging. The typical content of dry substance in silica sludge is 50 %. Also this process
5 has its drawbacks, as e.g. storing, transport and dosage.

The object of the present invention is to eliminate the drawbacks described above and to provide a process by means of which it is possible to produce
10 in an entirely new manner an active fine aggregate considerably more efficient than the previous ones, the use of which aggregate makes it always possible to achieve the final result desired. This object is achieved by means of the process of the invention
15 characterized in that a raw material mixture is made containing substantially dry inactive and/or weakly active components selected from a group consisting of e.g. limestone, quartz, lump slag, granulated and pelletized blast-furnace slag; and silica or another
20 substance containing an abundance of fine amorphous silicon oxide; and that this substantially dry raw material mixture is ground in a mill or the like, as a result of which joint grinding the silica or the other substance containing an abundance of fine amor-
25 phous silicon oxide activates the surfaces of the inactive and/or weakly active components to react easily with the calcium hydroxide.

In the process of the invention, the silica or the other substance containing an abundance of fine
30 amorphous silicon oxide is thus ground in a mill together with the inactive and/or only weakly active materials. The silica, preferably pelletized, then decomposes into very small particles, and according to research, a large part of these particles adheres
35 to the surface of the rest of the material ground and

changes the surface of the inactive and/or weakly active material to react very easily with the calcium hydroxide. Another advantage of the process is that the need for water in concrete does not increase at all even though silica is used. The silica added to the grinding can also be unpelletized. This kind of silica changes during grinding in such a way that it can be used for the preparation of concrete. In practice, the share of the pozzolanic substances is some percentages by weight, as practical upper limit can be considered 50 % by weight.

When using the process of the invention, attention is paid to the grain size distribution of the product created. The grain size distribution is selected in such a way that it fills as well as possible the area remaining between the smallest grains of natural stone aggregate and the largest cement grains, which area by nature lacks grains. Consequently, the average grain size of this product, which can, for instance, be called an active filler, is larger than the average grain size of cement and smaller than that of natural fine aggregate. By using the active filler produced by the process of the invention, it is possible to compensate the lacking grain size area by an inactive and/or weakly active basic material, the surface of which is activated by means of a pozzolanic substance. A product of this kind has substantially cheaper production costs than a product with cement properties having the same effect on the strength development of concrete.

Very fine materials, as e.g. silica, increase the need for water in connection with the preparation of concrete, when they are dosed in traditional manners. The main part of the fine material in the product prepared according to the invention has ad-

hered during grinding to the surface of the basic material, and consequently, it does not increase the need for water in concrete. Because, however, a part of the fine material consists of very small loose particles in the product, a plasticizer, as e.g. lignosulphate, is preferably added into the mill at the preparation of the product, which plasticizer adhered to the surface of the fine particles ensures a dispersion of the fine material in the concrete mix.

10 Results of research

In tests was used a fine aggregate containing 3 % of silica ground together with lump slag. The dosage of this aggregate into the concrete was 50 kg/m³. 200 kg/m³ of cement was used in the concrete. It was possible to prove by means of calculations that the effect of the silica on the compression strength of the concrete at the age of 28 days was 4...5 MPa. To achieve a corresponding additional strength it would have been necessary to add approximately 20 kg/m³ of cement instead of the 1,5 kg of silica now added. Consequently, the activity of silica obtained was over 10 compared with cement. According to the test results of the literature and to the applicant's own test results, the activity of silica compared with cement is about 3. In accordance with these tests, the activity of silica increased more than threefold.

25 Example

A typical composition (% by weight) of the raw material mixture and thus of the final product discussed in the process is, depending on the use, as follows:

- 30 0 > silica ≤ 10 %
 0 ≥ inactive materials, as limestone ≤ 15 %
 0 ≥ grinding additive, as lignosulphate ≤ 5 %
35 the rest weakly active materials, as lump slag.

In connection with grinding, to the mill is preferably added grinding additive contributing to the grinding as well as to a dispersion of the finest grains into the concrete mix.

5 The grain size curve of the product is adjusted in such a way that it compensates the lacking grain sizes of the concrete in the best possible manner. The grain size distribution is adjusted by dosing into the mill materials to be ground in different
10 ways in a ratio desired. In the product created in this way, the main part of the material belongs to the grain size area of 0...300 μm .

 By changing the grading, the activity of the basic material and the quality and dosage of the poz-
15 zolana, it is possible to produce different fine aggregates for different concretes.

Claims:

1. A process for producing an active fine aggregate for the preparation of concrete, c h a r -
5 a c t e r i z e d in that a raw material mixture is made containing substantially dry inactive and/or weakly active components selected from a group consisting of e.g. limestone, quartz, lump slag, granulated and pelletized blast-furnace slag; and silica
10 or another substance containing an abundance of fine amorphous silicon oxide; and that this substantially dry raw material mixture is ground in a mill or the like, as a result of which joint grinding the silica or the other substance containing an abundance of
15 fine amorphous silicon oxide activates the surfaces of the inactive and/or weakly active components to react easily with the calcium hydroxide.

2. A process according to claim 1, c h a r -
a c t e r i z e d in that the share of silica or
20 another substance containing an abundance of fine silicon oxide is 50 % by weight at the most, preferably less than 10 % by weight.

3. A process according to claim 1 or 2,
c h a r a c t e r i z e d in that the composition of
25 the fine aggregate is as follows:

- 10 % by weight of silica at the most;
- 15 % by weight of inactive components, as limestone, at the most;
- 5 % by weight of a grinding additive, as
30 lignosulphonate, at the most; and
- the rest inactive components, as lump slag.

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 90/00250

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: C 04 B 18/30																	
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%; border-bottom: 1px solid black;">Classification System</td> <td style="border-bottom: 1px solid black;">Classification Symbols</td> </tr> <tr> <td style="height: 40px; vertical-align: bottom;">IPC5</td> <td style="vertical-align: bottom;">C 04 B</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸</div> <p>SE,DK,FI,NO classes as above</p>			Classification System	Classification Symbols	IPC5	C 04 B											
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III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category *</th> <th style="width: 70%; border-bottom: 1px solid black;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 20%; border-bottom: 1px solid black;">Relevant to Claim No.¹³</th> </tr> <tr> <td style="vertical-align: top;">X</td> <td>DE, A1, 2458304 (KROPFHAMMER, GEORG) 16 June 1976, see page 2, line 34 - page 3, line 8; page 5, line 4 - line 8 --</td> <td style="vertical-align: top;">1-2</td> </tr> <tr> <td style="vertical-align: top;">X</td> <td>US, A, 4306912 (BENGT FORSS) 22 December 1981, see column 4, line 48 - line 54; column 7, line 43 --</td> <td style="vertical-align: top;">1-2</td> </tr> <tr> <td style="vertical-align: top;">X</td> <td>DE, A, 2259898 (STEAG HANDEL GMBH) 12 June 1974, see page 4, line 26 - line 27; page 5, line 5 - line 6 --</td> <td style="vertical-align: top;">1-2</td> </tr> <tr> <td style="vertical-align: top;">A</td> <td>BE, A, 839899 (CENTRE DE RECHERCHES METALLURGIQUES) 16 July 1976, see the whole document -- -----</td> <td style="vertical-align: top;">1-3</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	DE, A1, 2458304 (KROPFHAMMER, GEORG) 16 June 1976, see page 2, line 34 - page 3, line 8; page 5, line 4 - line 8 --	1-2	X	US, A, 4306912 (BENGT FORSS) 22 December 1981, see column 4, line 48 - line 54; column 7, line 43 --	1-2	X	DE, A, 2259898 (STEAG HANDEL GMBH) 12 June 1974, see page 4, line 26 - line 27; page 5, line 5 - line 6 --	1-2	A	BE, A, 839899 (CENTRE DE RECHERCHES METALLURGIQUES) 16 July 1976, see the whole document -- -----	1-3
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 50%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div>																	
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border-bottom: 1px solid black;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="height: 40px; vertical-align: bottom;">24th January 1991</td> <td style="vertical-align: bottom; text-align: center;">1991 -01- 25</td> </tr> <tr> <td style="border-bottom: 1px solid black;">International Searching Authority</td> <td style="border-bottom: 1px solid black;">Signature of Authorized Officer</td> </tr> <tr> <td style="height: 40px; vertical-align: bottom; text-align: center;">SWEDISH PATENT OFFICE</td> <td style="vertical-align: bottom; text-align: center;"> May Hallne </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	24th January 1991	1991 -01- 25	International Searching Authority	Signature of Authorized Officer	SWEDISH PATENT OFFICE	 May Hallne							
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ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/FI 90/00250

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 90-11-28
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A1- 2458304	76-06-16	NONE	
US-A- 4306912	81-12-22	AU-B- 537598	84-07-05
		AU-D- 5880480	80-12-04
		BE-A- 883533	80-09-15
		CA-A- 1150327	83-07-19
		CH-A- 644573	84-08-15
		DE-A-C- 3020384	80-12-11
		FR-A-B- 2457845	80-12-26
		GB-A-B- 2051031	81-01-14
		JP-A- 55162456	80-12-17
		NL-A- 8003179	80-12-02
		SE-B- 447097	86-10-27
		SE-A- 8003922	80-12-01
DE-A- 2259898	74-06-12	NONE	
BE-A- 839899	76-07-16	LU-A- 76984	77-07-18